

Virtual Reality Exposure Therapy and Standard (in Vivo) Exposure Therapy in the Treatment of Fear of Flying

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This controlled clinical trial tested virtual reality exposure (VRE) therapy for the fear of flying (FOF), a relatively new and innovative way to do exposure therapy, and compared it to standard (in vivo) exposure therapy (SE) and a wait list (WL) control with a 6- and 12-month follow-up. Eighty-three participants with FOF were randomly assigned to VRE, SE, or WL. Seventy-five participants, 25 per group, completed the study. Twenty-three WL participants completed randomly assigned treatment following the waiting period. Treatment consisted of 4 sessions of anxiety management training followed either by exposure to a virtual airplane (VRE) or an actual airplane at the airport (SE) conducted over 6 weeks. Results indicate that VRE was superior to WL on all measures, including willingness to fly on the posttreatment flight (76% for VRE and SE; 20% for WL). VRE and SE were essentially equivalent on standardized questionnaires, willingness to fly, anxiety ratings during the flight, self-ratings of improvement, and patient satisfac-

tion with treatment. Follow-up assessments at 6 and 12 months indicated that treatment gains were maintained, with more than 70% of respondents from both groups reporting continued flying at follow-up. Based on these findings, the use of VRE in the treatment of FOF was supported in this controlled study, suggesting that experiences in the virtual world can change experiences in the real world.

Drs. Rothbaum and Hodges receive research funding and are entitled to sales royalty from Virtually Better, Inc., which is developing products related to the research described in this article. In addition, they serve as consultants to and own equity in Virtually Better, Inc. The terms of this arrangement have been reviewed and approved by Emory University and Georgia Institute of Technology in accordance with their conflict of interest policies.

This study was supported by NIMH Grant #2-R42-MH58493-02. Thanks go to Edna Foa, Ph.D., for consultation during this research, and Dan Whitaker, Ph.D., for statistical consultation.

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0005-7894/06/080-090\$1.00/0

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THE BEST ESTIMATE of fear of flying (FOF) is 10% to 40% (Dean & Whitaker, 1982; Van Gerwen & Diekstra, 2000), or approximately 25 million adults in the U.S., many of whom avoid flying entirely. As many as 20% of all flyers depend on alcohol or sedatives to reduce anxiety symptoms during flights (Griest & Griest, 1981; Howard, Murphy, & Clarke, 1983). Since the September 11 terrorist attacks, there has been a 10% to 30% decrease in airline travel, affecting the airline industry, the business community, and the overall economy (Ito & Lee, 2004).

FOF treatment programs are increasingly popular and lucrative. Most of these programs use a CBT approach including both anxiety management (e.g., relaxation training, cognitive restructuring, psychoeducation) and exposure (i.e., flying) (Van Gerwen, Spinhoven, Diekstra, & Van Dyck, 2002). Many FOF programs affiliated with the airlines (see Van Gerwen & Diekstra, 2000, for a review) report positive outcomes but do not conduct standardized research, with the exception of Van Gerwen et al. (2002).

Virtual reality (VR) has developed as one of several new computer-based formats for the delivery of exposure therapy (Anderson, Jacobs, & Rothbaum, 2004). The use of VR in the treatment of anxiety disorders is receiving increasing scientific (Anderson, Rothbaum, & Hodges, 2000; Zimand et al., 2002; Zimand, Rothbaum, Tannenbaum, Ferrer, & Hodges, 2003) and public (Carmichael, Kovach, Mandel, & Wehunt, 2001; Hoffman, 2004; Szegedy-Maszak, 2004) attention. VR is a human-computer interaction paradigm in which users are active participants within a computer-generated three-dimensional virtual world. To become part of the virtual world, the user wears an immersive head-mounted display (HMD) that consists of a display screen for each eye, earphones, and a head-tracking device, while sitting or standing on a low platform atop a bass speaker, thus placing the user within a multisensory, 360-degree environment that can provide visual, auditory, and kinesthetic cues (i.e., vibrations). Natural body and head motion by the user corresponds to change within the virtual world. The image seen by the user in the HMD is displayed on a computer monitor for the therapist to view.

A sense of presence, essential to conducting exposure therapy, distinguishes VR from an interactive computer graphics display. Regenbrecht, Schubert, and Friedmann (1998) studied the sense of presence in which arousal is elicited by the user "developing a mental representation of the virtual stimuli as one's own environment" (p. 246). Although the user's experience is entirely computer-generated, the individual's perception overlooks the role of technology in the experience (Krijn, Emmelkamp, Olafsson, & Biemond, 2004).

There are several advantages to VR for FOF and other exposures. VR exposure (VRE) takes place in a therapy office, which is more convenient and provides an intermediate step between the therapy office and the real world (Botella, Osma, Garcia-Palacios, Quero, & Banos, 2004). As a result, researchers have suggested that VR exposure has greater appeal over in vivo exposure and may help more individuals who meet criteria for an anxiety disorder to seek treatment (Garcia-Palacios, Hoffman, See, Tsai, & Botella, 2001). For FOF, it is less expensive to pay for VR sessions in a therapist's office than to purchase airline tickets and pay for the therapist to accompany the client. Confidentiality can more easily be maintained relative to in vivo exposure conducted in a public place. Finally, VR can effectively meet the basic criteria for exposure, including a high degree of control, the ability to present anxiety-producing stimuli over

and over, and the ease of prolonging the exposure in order to achieve habituation (Foa & Kozak, 1986; Foa, Steketee, & Rothbaum, 1989).

A body of research is accumulating supporting the use of VRE within a comprehensive treatment program for anxiety disorders. Case studies support the use of VRE in the treatment of anxiety disorders, including specific phobia of flying (North, North, & Coble, 1997; Rothbaum, Hodges, Watson, Kessler, & Opdyke, 1996; Smith, Rothbaum, & Hodges, 1999; Wiederhold, Gevirtz, & Wiederhold, 1998), specific phobia of spiders (Carlin, Hoffman, & Weghorst, 1997), claustrophobia (Botella et al., 1998; Botella, Banos, Villa, Perpina, & Garcia-Palacios, 2000), acrophobia (Choi, Jang, Ku, Shin, & Kim, 2001; Rothbaum et al., 1995b), and social anxiety (Anderson, Rothbaum, & Hodges, 2003). Two case studies have reported that VRE was successful at reducing PTSD symptoms: one in a Vietnam veteran (Rothbaum et al., 1999) and another in a survivor of the 9/11 World Trade Center attacks (DiFede & Hoffman, 2002).

These case studies were followed by successful open clinical trials without comparison groups for combat-related PTSD (Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001), social anxiety (Anderson, Rothbaum, Hodges, & Zimand, submitted for publication), acrophobia (Emmelkamp, Bruynzeel, Drost, & van der Mast, 2001), post-earthquake traumatic stress (Basoglu, Livanou, & Salcioglu, 2003), and FOF (Botella et al., 2004). A recent application of VR to fear of driving (Wald, 2004) with five participants in a multiple-baseline across-subjects design yielded only modest outcome in anxiety reduction and did not result in generalization to actual driving behavior.

Randomized clinical trials comparing VRE to wait list (WL) control groups have been conducted for several of the anxiety disorders. The first published controlled study used VRE therapy compared to WL for the treatment of acrophobia (Rothbaum et al., 1995a). Another controlled study demonstrated the efficacy of VRE therapy compared to WL for reducing public speaking anxiety among university students (Harris, Kemmerling, & North, 2002). A drawback to these studies is the small sample sizes, ranging from 10 to 20 participants.

Several controlled trials using VRE for fear of heights and flying have been conducted by independent researchers around the world. Emmelkamp and colleagues (2002) compared in vivo exposure with an exact replication of the environment in VR for acrophobia ($N = 33$). Participants in both treatments reported reduced anxiety, avoidance,

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